

April 2011 JPM / CS / APS / EPSS / PSHS Joint Subcommittee Meeting

ABSTRACT SUBMITTAL FORM

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ABSTRACT INFORMATION

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ABSTRACT SUBMITTAL FORM

Unclassified Abstract

(250-300 words; do not include figures or tables)

CLVTOPS is a multi-body time domain flight dynamics simulation tool developed by NASA's Marshall Space Flight Center (MSFC) for a space launch vehicle and is based on the TREETOPS simulation tool. CLVTOPS is currently used to simulate the flight dynamics and separation/jettison events of the Ares I launch vehicle including liftoff and staging separation. In order for CLVTOPS to become an accredited tool, validation against other independent simulations and real world data is needed.

The launch of the Ares I-X vehicle (first Ares I test flight) on October 28, 2009 presented a great opportunity to provide validation evidence for CLVTOPS. In order to simulate the Ares I-X flight, specific models were implemented into CLVTOPS. These models include the flight day environment, reconstructed thrust, reconstructed mass properties, aerodynamics, and the Ares I-X guidance, navigation and control models. The resulting simulation output was compared to Ares I-X flight data. During the liftoff region of flight, trajectory states from the simulation and flight data were compared. The CLVTOPS results were used to make a semi-transparent animation of the vehicle that was overlaid directly on top of the flight video to provide a qualitative measure of the agreement between the simulation and the actual flight. During ascent, the trajectory states of the vehicle were compared with flight data. For the stage separation event, the trajectory states of the two stages were compared to available flight data. Since no quantitative rotational state data for the upper stage was available, the CLVTOPS results were used to make an animation of the two stages to show a side-by-side comparison with flight video. All of the comparisons between CLVTOPS and the flight data show good agreement.

This paper documents comparisons between CLVTOPS and Ares I-X flight data which serve as validation evidence for the eventual accreditation of CLVTOPS.